Howard Hanson Dam: Green River and Howard Hanson Reservoir Water Quality Sampling and Analysis Plan 2008

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Introduction

Howard Hanson Dam (HHD) was authorized in 1950 for flood control and water supply for municipal, industrial, and irrigation purposes, but water supply was never implemented. Since 1989, the Seattle District has investigated the potential for the project to help meet increasing Municipal and Industrial water supply needs for the Puget Sound area through the Howard Hanson Dam (HHD) additional water storage project (AWSP). The HHD-AWSP raised the maximum elevation of stored water from 1147 feet to 1167 feet in 2007. Because these water storage and operational changes may alter the reservoir’s water quality, the U.S. Army Corps of Engineers (COE) will monitor the water quality of the reservoir before and after the maximum elevation pool is raised. Based on water quality data collected before and after the pool raise, operational changes may be implemented to maintain water quality.

This sampling and analysis plan provides details on the methods and protocols that will be used for the HHD-AWSP. This monitoring plan was developed in accordance with Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology 2001), and includes the following elements:

- Project organization
- Project description
- Sampling procedures
- Analytical procedures
- Data quality objectives
- Data assessment procedures and corrective actions
- Data management procedures and reporting.
Project Organization and Schedule

The following section will outline the project organization and schedule for the Howard Hanson Reservoir water quality monitoring project.

Project Organization

The Seattle District is the project proponent and lead agency for the Howard Hanson Reservoir water quality monitoring program. The Seattle District is responsible for conducting all water quality monitoring. Howard Hanson Dam personnel will assist the Seattle District with collecting water samples in the Green River and Howard Hanson Reservoir. A Washington State Department of Ecology or U.S. EPA approved water quality laboratory will be responsible for analysis of the water samples. Specific responsibilities of key personnel are shown below:

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(206) 632-2715
Steven Lazoff Laboratory Manager
Project Schedule

The water quality monitoring program shall collect surface water samples every three weeks from April through October 2008. Water quality samples will be delivered to Aquatic Research Inc., an EPA-accredited laboratory, within 24 hours of collection. The laboratory will report the analytical results to the COE project manager within 30 days. The sample and quality control data will be reviewed by the quality assurance (QA) officer within 14 days. A draft project report will be completed within 6 weeks of receiving the final set of data from the laboratory. A final project report will be completed within 2 weeks of receiving comments on the draft project report.
Project Description

The following section will provide background information, monitoring program objectives, and parameters of concern for the Howard Hanson Reservoir water quality monitoring program.

Background Information

The project is located along the Green River in Howard Hanson Reservoir upstream of Howard Hanson Dam (Figure 1). In the spring and summer of 2002, the COE conducted a test pool project which raised the maximum elevation of stored water in the reservoir from the typical elevation of 1147 feet to 1167 feet, to evaluate the impacts of the additional water storage on dam safety and water quality. Based on water quality data collected during the 2002 test pool raise, Tacoma Public Utilities expressed concerns that increasing the reservoir level may impact water quality, potentially resulting in degrading the drinking water quality provided by Howard Hanson Reservoir and the Green River.

Project Goals and Objectives

The goal of the 2008 monitoring program is to characterize the water quality of Howard Hanson Reservoir before and after the maximum pool elevation is raised from 1147 feet to 1167 feet to determine if water quality impacts are occurring during elevated reservoir storage conditions. Specifically, there is concern about the potential for increased reservoir elevations to lead to increased concentrations of nutrients, organic matter, and phytoplankton in the reservoir.

The objective of the monitoring program is to determine water quality conditions in Howard Hanson Reservoir collected during and after the pool raise operations. Water quality data collected during the test pool will be used to test whether there is a statistically significant difference between current conditions and future conditions with an elevated pool.

Sampling Design

To meet the project goals and objectives described above, water quality will be monitored in the Green River and Howard Hanson Reservoir before and after the pool elevation is raised. Water quality parameters of concern for Howard Hanson Reservoir include temperature, dissolved oxygen, nutrients (i.e. phosphorus and nitrogen), organic matter, chlorophyll a, phytoplankton, and zooplankton. These are the primary water quality factors that are potentially influenced by raising the water level of the reservoir. Additional water quality parameters such as pH, conductivity, and alkalinity will be monitored to help with the basic understanding of the limnology of the reservoir.
Figure 1. Vicinity map of the Howard Hanson Reservoir water monitoring program in Pierce County, Washington.
Sampling Procedures

Sampling procedures will generally follow Puget Sound Estuary Program (PSEP) protocols (U.S. EPA 1990, 1997) and United States Geological Survey (USGS) protocols (USGS 1999). Prior to each sampling event, the COE principal investigator will review sampling procedures and equipment needs with field technicians. This section identifies specific procedures for water sampling, preparing field notes, and decontaminating equipment. It also describes requirements for sample containers, preservation, holding times, identification, labeling, and handling.

Sampling Design

To meet the project goals and objectives described in the previous section, water quality will be monitored at Howard Hanson Dam at six (6) in-reservoir stations and two (2) river stations located upstream and downstream of the dam (Figure 2). The upstream station (GRAP) is located at about RM 70.0 near Railroad Bridge 71, approximately 5.5 miles upstream from the dam. The downstream station (HAHW) is located at RM 63.8 about 0.7 miles downstream of the dam at the site of the existing USGS Green River below Howard Hanson Dam gaging station (No. 12105900). Samples collected at these river stations will be from the bank. The in-reservoir stations will consist of one (1) up-reservoir station located about 4 miles upstream of the Dam (9UPNR) and one (1) forebay station located immediately upstream of the dam (1DAM). The in-reservoir stations will be collected from the reservoir thalweg which represents the deepest point at each sampling location. Water quality parameters of concern include temperature, pH, dissolved oxygen, alkalinity, nutrients (i.e. phosphorus and nitrogen) and plankton (Table 1).

Water Sampling

Between April and October 2008, water quality data will be collected about every three weeks at one downstream river station (HAHW), one upstream river station (GRAP) and two in-reservoir stations (9UPNR and 1DAM). Two sets of field duplicates will be collected to assess both environmental and analytical variability. Each sample will be analyzed for the parameters presented in Table 1.

All water quality sampling will be performed by two field technicians wearing new vinyl gloves and practicing clean hands-dirty hands field techniques. In-reservoir samples will be collected by submerging a cleaned and decontaminated 2.2 liter (L) polycarbonate (Lexan) van-dorn style sampler with ultra-clean seals to depth and filling. If the reservoir is not stratified at the station, samples will be collected from four depths between the surface and bottom, and equally composited in laboratory-cleaned, prelabeled sample containers at the surface. If the reservoir is stratified, samples will be collected from four depths in the epilimnion and hypolimnion, and equally composited in laboratory-cleaned, prelabeled sample containers at the surface. Photic zone samples for chlorophyll a analysis will be collected from up to five depths in the photic...
zone, and compositing them into a clean 22 L bucket at the surface. In-river samples will be collected from the bank of the river by submerging laboratory-cleaned, prelabeled sample containers below the water surface at mid-depth. Sample containers will be rinsed once prior to filling, capped with headspace for mixing or the addition of preservative, and immediately placed on ice in a cooler. Measurements of field parameters (see Table 1) will be performed in situ using a Hydrolab DataSonde 4a multiprobe coupled with a Surveyor 4 surface display and recording unit. Equipment used for field measurements will be calibrated prior to each sampling event.

Phytoplankton samples will be collected from the photic zone following the procedures used for chlorophyll a sample collection. Zooplankton samples will be collected by vertical tow from a depth of 10 meters to the surface using a 60 µm mesh net. Phytoplankton and zooplankton samples will be immediately placed on ice in a cooler and preserved with either a 1-percent lugols solution (phytoplankton) or 25 percent Isopropyl Alcohol solution (zooplankton) within 12 hours of sample collection.

Field Notes

At each water quality monitoring station, the following information will be recorded in a waterproof bound field notebook:

- Sampling date and name of sampler
- Time of sample collection, measurement, or observation
- Station location
- Weather and flow conditions
- Calibration results for field instruments
- Field measurements
- Number and type of samples collected
- Modifications of established sampling procedures.

Equipment Decontamination

It is not anticipated that sampling equipment needing decontamination will be used during this project. However, any sampling equipment used during the project will be decontaminated prior to collection of samples using the following procedures:

- Wash with phosphate-free detergent
- Rinse thoroughly with potable water
- Rinse with dilute, ultra-pure nitric acid solution (for metals analysis)
- Rinse thoroughly with deionized water.
Figure 2. Howard Hanson Reservoir water quality monitoring locations.
Table 1. Methods and detection limits for water quality analyses.

<table>
<thead>
<tr>
<th>Method Parameters</th>
<th>Method Number</th>
<th>Detection Limit/Unit</th>
<th>Container and Preservative</th>
<th>Holding Time</th>
<th>Water Quality Stations Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>SM 2550-B</td>
<td>0.1°C</td>
<td>—</td>
<td>Analyze</td>
<td>A</td>
</tr>
<tr>
<td>pH</td>
<td>SM 4500-H</td>
<td>—</td>
<td>P/G, 4°C</td>
<td>3 hours</td>
<td>A</td>
</tr>
<tr>
<td>Conductivity</td>
<td>SM 2510-B</td>
<td>1 μS/cm</td>
<td>P/G, 4°C</td>
<td>28 days</td>
<td>A</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>SM 4500-O-G</td>
<td>0.1 mg/L</td>
<td>G, Dark</td>
<td>8 hours</td>
<td>A</td>
</tr>
<tr>
<td>Laboratory Chemical Parameters</td>
<td>EPA 365.1</td>
<td>0.002 mg/L</td>
<td>P/G, 4°C, H2SO4 to pH&lt;2</td>
<td>28 days</td>
<td>A</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>EPA 365.1</td>
<td>0.001 mg/L</td>
<td>P/G, 4°C, filter immediately</td>
<td>48 hours</td>
<td>A</td>
</tr>
<tr>
<td>Soluble Phosphorus</td>
<td>SM204500N</td>
<td>0.050 mg/L</td>
<td>P/G, 4°C, H2SO4 to pH&lt;2</td>
<td>28 days</td>
<td>A</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>EPA 353.2</td>
<td>0.010 mg/L</td>
<td>P/G, 4°C, H2SO4 to pH&lt;2</td>
<td>28 days</td>
<td>A</td>
</tr>
<tr>
<td>Nitrate+Nitrite</td>
<td>EPA 350.1</td>
<td>0.010 mg/L</td>
<td>P/G, 4°C, H2SO4 to pH&lt;2</td>
<td>28 days</td>
<td>A</td>
</tr>
<tr>
<td>Ammonia</td>
<td>EPA 310.1</td>
<td>1.00 mg/L</td>
<td>P/G, 4°C</td>
<td>14 days</td>
<td>A</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>SM 1810200</td>
<td>0.0001 mg/L</td>
<td>P, 4°C, filter, add MgCO3</td>
<td>28 days</td>
<td>B</td>
</tr>
</tbody>
</table>

Laboratory Biological Parameters

<table>
<thead>
<tr>
<th>Method Parameters</th>
<th>Method Number</th>
<th>Detection Limit/Unit</th>
<th>Container and Preservative</th>
<th>Holding Time</th>
<th>Water Quality Stations Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytoplankton</td>
<td>—</td>
<td>—</td>
<td>P/G, 4°C, 1% Lugols</td>
<td>12 months</td>
<td>B</td>
</tr>
<tr>
<td>Zooplankton</td>
<td>—</td>
<td>—</td>
<td>G, 4°C, 5% Formaldehyde</td>
<td>12 months</td>
<td>B</td>
</tr>
<tr>
<td>Chlorophyll a</td>
<td>SM 1810200</td>
<td>0.0001 mg/L</td>
<td>P, 4°C, filter, add MgCO3</td>
<td>28 days</td>
<td>B</td>
</tr>
</tbody>
</table>

* SM method numbers are from APHA et al. (2000); EPA method numbers are from U.S. EPA (1983, 1984, and 1992).
A Stations GRAP, 9UPNR, 1DAM and HAHW for all months
B Stations 9UPNR and 1DAM for all months
Sample Identification and Labeling

Each sample will be identified by its station number and the date of collection. Prior to filling, sample containers will be labeled with the following information using indelible ink:

- Station ID
- Date of collection (month/day/year)
- Time of collection (military format)
- Project ID
- Company/sampler initials.

Sample Containers, Preservation, and Holding Times

Pre-cleaned sample containers will be obtained from the analytical laboratory for the required analyses. Spare sample containers will be carried by the sampling team in case of breakage or possible contamination. Sample containers, preservation techniques, and holding times will follow PSEP (U.S. EPA 1990), U.S. EPA (40 Code of Federal Regulations [CFR] 136, July 1, 1992) and Ecology (2001) guidelines (Table 1).

Sample Handling

Pre-cleaned sample containers will be provided by the analytical laboratory and secured in a clean cooler prior to use. Samples will be stored at 4°C in a cooler and transported to the laboratory within 24 hours of collection. A chain-of-custody record will accompany the samples that clearly identifies the analytical parameters and methods.
Analytical Procedures

Analytical methods and detection limits and are presented in Table 1. Field measurements of temperature, pH, conductivity, turbidity and dissolved oxygen will be conducted in situ using portable meters operated according to the manufacturer’s directions and following standard measurement procedures (APHA, et al. 2000). Laboratory analytical procedures will follow U.S. EPA approved methods (APHA et al. 2000; U.S. EPA 1983, 1984). These methods provide detection limits that are below the state and federal regulatory criteria or guidelines, and will enable direct comparison of analytical results with these criteria.

The laboratory identified for this project (Aquatic Research, Inc.) is certified by Ecology and participates in audits and interlaboratory studies by Ecology and U.S. EPA. These performance and system audits have verified the adequacy of the laboratory standard operating procedures, which include preventative maintenance and data reduction procedures.

The laboratory will report the analytical results within 30 days of receipt of the samples. Sample and quality control data will be reported in a standard format. The reports will also include a case narrative summarizing any problems encountered in the analyses.
Data Quality Objectives

The overall quality assurance objective is to ensure that data of known and acceptable quality are obtained. All measurements will be performed to yield consistent results that are representative of the media and conditions measured. Specific objectives and procedures for precision, accuracy, representativeness, completeness, and comparability are identified below. In this document, the term “detection limit” refers to the practical quantitation level established by the laboratory, not the method detection limit.

- **Precision.** Precision will be assessed using a laboratory duplicate that will be analyzed at random with every sample batch (i.e., sampling event) and a field duplicate that will be analyzed at a frequency of at least 5 percent of the total number of samples submitted (i.e., one in 20 samples). Two levels of precision for duplicate analyses will be evaluated. The relative percent difference (RPD) of laboratory duplicates will be less than or equal to 25 percent for values that are greater than 5 times the detection limit, and ±2 times the detection limit for values that are less than or equal to 5 times the detection limit.

- **Accuracy.** Accuracy will be assessed using laboratory preparation blanks, matrix spikes, and control standards. Where applicable, these quality control analyses will be performed for every sample batch at a frequency of at least 5 percent of the total number of samples submitted. The values for blanks will not exceed 2 times the detection limit. The percent recovery of matrix spikes will be between 75 and 125 percent. The percent recovery of control standards will be between 80 and 120 percent.

- **Representativeness.** Sample representativeness will be ensured by employing consistent and standard sampling procedures.

- **Completeness.** A minimum of 95 percent of the sample analysis results reported by the laboratory will be judged valid. It is anticipated that all samples will be collected. An equipment checklist will be used to prevent loss of data resulting from missing containers or inoperable instruments prior to embarking on field sampling trips.

- **Comparability.** Data comparability will be ensured through the application of standard sampling procedures, analytical methods, units of measurement, and detection limits. The results will be tabulated in standard spreadsheets for comparison with threshold limits and background data.
Data Assessment Procedures and Corrective Actions

Field and laboratory data will be reviewed by the quality assurance officer immediately upon receipt. Quality control problems and corrective actions will be summarized in a quality assurance worksheet. Values associated with minor quality control problems will be considered estimates and assigned a “J” qualifier. Values associated with major quality control problems will be rejected and assigned an “R” qualifier. Estimated values may be used for evaluation purposes, while rejected values will not be used. Data assessment procedures are described below for the following quality control elements:

- Completeness
- Methodology
- Holding times
- Blanks
- Detection limits
- Laboratory duplicates
- Matrix spikes
- Control standards.

Completeness

Completeness will be assessed by comparing valid sample data with this quality assurance project plan and the chain-of-custody records. Completeness will be calculated by dividing the number of valid values by the total number of values. Samples will be reanalyzed or re-collected if completeness is less than 95 percent.

Methodology

Methodology will be assessed by examination of the field notebook and laboratory reports for deviation from this quality assurance project plan. Unacceptable deviations will result in rejected values (R) and will be corrected for future analyses.

Holding Times

Analysis dates will be reported by the laboratory. Holding times will be assessed by comparing analytical dates to sample collection dates and times. Values that exceed the maximum holding time required by U.S. EPA (1992 and 1996) will be considered estimates (J), whereas severe exceedances will result in rejected values (R).
Blanks

Preparation blanks consisting of de-ionized distilled water will be analyzed and the results will be reported in each laboratory report. Sample values that are less than 5 times a detected blank value will be considered estimates (J).

Detection Limits

Detection limits will be reported in each laboratory report. If proposed detection limits are not met by the laboratory, the laboratory will be requested to reanalyze the samples and/or revise the method, if time permits.

Laboratory Duplicates

Precision of laboratory duplicate results will be presented in each laboratory report. Data for batch samples (i.e., samples from other projects analyzed with samples from this project) will be acceptable as long as project sample duplicates are analyzed at a frequency of at least 5 percent. Precision of field and laboratory duplicate results will be calculated according to the following equation:

\[
RPD = \left( \frac{C_1 - C_2}{C_1 + C_2} \right) \times 100\%
\]

where:
- \( RPD \) = relative percent difference
- \( C_1 \) = larger of two values
- \( C_2 \) = smaller of two values.

Laboratory duplicate results exceeding the objectives will be noted in the quality assurance worksheets, and associated values will be flagged as estimates (J). If the objectives are severely exceeded (e.g., more than twice the objective), then associated values will be rejected (R). Field duplicate results exceeding the objectives will be noted and only used to flag data upon consideration of all quality control data.

Matrix Spikes

Accuracy of matrix spike results will be presented in each laboratory report. Data for batch samples will be acceptable as long as spikes of project samples are analyzed at a frequency of at least 5 percent. Accuracy of matrix spike results will be calculated according to the following equation:
\[
\%R = \frac{(S - U) \times 100\%}{C_{sa}}
\]

where:
- \(\%R\) = percent recovery
- \(S\) = measured concentration in spike sample
- \(U\) = measured concentration in unspiked sample
- \(C_{sa}\) = actual concentration of spike added.

If the analyte is not detected in the unspiked sample, then a value of zero will be used in the equation.

Results exceeding the objective will be noted in the quality assurance worksheets, and associated values will be flagged as estimates (J). However, if the percent recovery exceeds 125 and a value is less than the detection limit, the result will not be flagged as an estimate. Nondetected values will be rejected (R) if percent recovery is less than 30 percent.

**Control Standards**

Accuracy of control standards will be presented in each laboratory report and checked by the quality assurance officer. Accuracy for these elements will be calculated according to the following equation:

\[
\%R = \frac{(M - T) \times 100\%}{T}
\]

where:
- \(\%R\) = percent recovery
- \(M\) = measured value
- \(T\) = true value.

Results exceeding the objective will be noted in the quality assurance worksheets, and associated values will be flagged as estimates (J). If the objectives are severely exceeded (e.g., more than twice the objective), then associated values will be rejected (R).
Data Management and Reporting

Water quality data will be entered in a numerical format in a Microsoft Excel spreadsheet following a quality assurance review. The results will be arranged chronologically for each station by sampling date across the spreadsheet columns. Data flags will be entered in separate columns adjacent to each data column using the following coding system:

- U = Analyte not detected at specified detection limit
- J = Estimated value
- R = Rejected value.

A monitoring report will be prepared upon completion of the data review and entry. This report will provide background information, data collection and analysis methods, tabulated and graphical presentations of the data, statistical test results, discussion of the results, conclusions, references, and appendices. Laboratory reports and quality assurance worksheets will be included in the monitoring report. Any problems and associated corrective actions taken will be reported. Specific quality assurance information that will be noted in the report includes the following:

- Changes in the monitoring/quality assurance plan
- Results of performance and/or system audits
- Significant quality assurance problems and recommended solutions
- Data quality assessment in terms of precision, accuracy, representativeness, completeness, comparability, and detection limits
- Discussion of whether the quality assurance objectives were met, and the resulting impact on decision-making
- Limitations on use of the measurement data.
References


